the Earth and Sun the explanation of the average fall of temperature,* while in the incompleteness of meteoric rings we find explanation of the frequent absence of all fall of temperature at these times; and in the great wealth of that part of such systems which has been poetically called the gem of the meteor ring we find an explanation of the intense cold often felt on the ill-omened days, such cold as to justify what has been said of the three April "cold days"—

> The first of them is wan and weet,
> The second it is cold and sleet,
> The third it comes with sic a freeze
> As gars the birds stick to the trees.

It would be of interest, I believe, to many if at those places where underground temperature is noted the average and also the actual temperatures for the cold days could be noted during many successive years. If meteoric shadow is in question, it is probable that the meteor systems, or at least those parts which cast the shadow, are near the Sun. If so, there might be some slight but discernible change in the solar spectrum on those days. If (as I trust) Dr. Huggins has really succeeded in securing photographs of the solar corona with the Sun uneclipsed, and if (as I believe) the outer coronal radiations are meteoric, we may be able before long to obtain more definite information on this question. It may even perhaps be shown that more extended meteorological relations depend on meteoric systems near the Sun, and that Sun-spots may be relieved of part of the imputations cast on them as weather-breeders. We might even find in meteoric periodicity near the Sun the explanation of Sun-spots themselves.

The Aquariads of April 29 to May 3 (Tupman, No. 33).

By W. F. Denning.

On April 30 and May 2–3, 1870, and again on April 29, 1871,† Col. Tupman observed a remarkably fine shower of meteors from points averaging $326° - 2\frac{1}{2}°$ near α *Aquarii*. The meteors were very brilliant, with streaks and long paths. This shower, being only visible for a short interval before sunrise, has received no good confirmation from subsequent observations. But it now appears that the recently published *Osservazioni di Stelle Cadenti fatte nelle stazioni Italiane durante gli anni* 1868, 1869 *e* 1870, in which are recorded the paths of 7602 shooting stars (chiefly

* It may be observed that in our almanacs no notice is taken of the peculiarity. It is treated as merely accidental, and the average temperatures are corrected (?) so as to rise and fall uniformly throughout the year. Buchan gives in his *Handy-book of Meteorology* a meteorological explanation which might hold but for Mr. Russell's evidence.

† There is some doubt as to the year in this case. In the B. A. Catalogue of Col. Tupman's observations it is given as 1871, but in the *Monthly Notices*, vol. xxxiii. p. 301, it is stated as 1869.

observed in 1870), that many of the meteors of Col. Tupman's shower were seen by the Italians, though the fact has previously escaped comment, as the observations have never been reduced. I have projected the apparent paths of 229 meteors in this catalogue recorded during the period from April 29 to May 6, 1870, between the hours of 13 and $15\frac{1}{2}$, and find that at least 45 of these appear most unquestionably to have belonged to this shower of Aquariads, and the confirmation is important as being based on observations made simultaneously with those of Col. Tupman.

The radiant point of this stream, as I have derived it from this new source, is at $335°-9°$, which is some 11° S.E. of the place determined by Col. Tupman. I projected the apparent paths both upon the star charts prepared by the B. A. Committee on Luminous Meteors and upon a celestial globe of 18 in. diameter. I adopted the latter plan as a means of finding the length of path traversed in each case. The average of 45 meteors (24 of which were seen on the morning of May 4, 1870) is 34°·7, which is much greater than the ordinary length of meteor tracks. Their brightness also appears to have been very exceptional, 1 being estimated=♀, 2=♃, and 13=first mag. stars. The mean length of 11 Aquariads registered by Col. Tupman on the morning of May 3, 1870, was 20°·5, which also far exceeds the average; and Mr. Corder, at Writtle, describes three of the meteors of this shower observed by him on the morning of May 4, 1878, as "remarkable for great length of path." These Aquariads are usually represented as swift, with bright streaks; and the inordinately long flights thus attributed to them by several different observers sufficiently prove them to have been directed from a radiant point very low on the horizon.

Giuseppe Zezioli, at Bergamo, recorded three Aquariads on the morning of May 3, 1868; and Mr. Corder has fixed the position of the radiant at $334°-5°$ from six "fine long meteors," which he himself observed* before daybreak at the end of April and beginning of May. My own efforts to observe this shower have generally been frustrated either by clouded skies or moonlight. In 1880 it must, however, have become extremely feeble, for watching the eastern sky between $14^h\ 15^m$ and 15^h on May 2 I only saw two shooting stars, of which one was clearly an Aquariad.† It rose upwards in the W. region of *Pegasus*, and was therefore not far from the radiant point which from this single observation I judged to lie slightly to the E. of the position assigned by Mr. Corder.

It seems obvious from the reduction of the meteors seen in Italy in 1870 and from Mr. Corder's later observations that the radiant point of this brilliant shower is really situated to the S.E. of the place originally given by Col. Tupman. This may be easily settled by future observations if the display continues

* *Monthly Notices*, vol. xl. p. 135, radiant No. 23.
† *Observatory*, vol. iii. p. 449.

actively visible. Certainly on the morning on May 3, 1880, it was very feeble, and may now quite possibly have died out altogether. It should, however, be looked for with close attention during the next few years. The shower is a very important one, inasmuch as it agrees with the radiant point computed for Halley's Comet (1835, III.), whose nearest approach to the Earth's orbit occurs twelve days before reaching the descending node. Prof. Herschel gives the cometary radiant as $337° \pm 0°$ May 4,* and this falls significantly close to the meteoric radiant. The agreement, though striking, may of course be purely accidental, but there is no doubt this shower of meteors should be assiduously looked for with a view to determine the exact centre of divergence, and whether its activity has been sustained since the very rich display of 1870.

The following are the observed paths of 45 meteors registered by the Italians in 1870, and presumably belonging to this shower of Aquariads:—

Date and Hour. 1870.	Mag.	Observed Path From α δ	To α δ	Length of Path.	Appearance.	Observer.
April 29.						
h m						
13 27	1	337 + 54	151 + 53	85	V. slow; streak	V.
14 32	2	195 + 74	164 + 41	36	Swift; streak	V.
13 36	2	351 + 61	120 + 69	45	,,	Gi.
April 30.						
15 20	3	182 + 58	163 + 41	21	V. swift	M.
15 20	4	182 + 58	165 + 46	16	,,	M.
May 3.						
14 25	2	170 + 83	163 + 61	22	Swift; streak	V.
14 40	3	20 + 64	68 + 73	19	Swift	V.
15 55	3	250 + 64	203 + 54	25	Slow	V.
14 52	3	319 + 11	312 + 37	27	Swift; streak	Bz.
14 53	2	157 + 81	158 + 62	19	,,	Ga.
14 55	3	327 + 17	317 + 41	25	Swift	Bz.
15 8	3	160 + 90	160 + 69	21	V. swift	Ba.
15 28	3	190 + 80	166 + 60	21	Swift	C.
14 15	1	3 + 39	28 + 50	21	Swift; streak	I.
14 26	1	268 + 40	202 + 48	47	,,	I.
14 26	4	202 + 56	178 + 47	18	Swift	I.
14 41	2	357 + 30	13 + 43	18	Swift; streak	I.
15 5	4	180 + 78	146 + 50	31	,,	I.
15 36	3	349 + 60	29 + 73	20	Slow	I.

* B. A. Report on Luminous Meteors for 1875, pp. 229, 232. *Monthly Notices*, vol. xxxvi. p. 222, and vol. xxxviii. p. 379.

Date and Hour. 1870.	Mag.	Observed Path From α	δ	To α	δ	Length of Path.	Appearance.	Observer.
May 3.								
h m								
13 40	♀	359	+31	121	+58	88	V. slow	Z.
13 55	1	357	+37	7	+47	12	Swift	Z.
13 57	1	294	+11	265	+32	34	V. swift	Z.
14 43	1	322	+ 8	313	+17	12	Swift	Z.
13 8	3	8	+56	26	+63	11	V. swift	M.
13 46	1	339	+29	40	+55	50	V. slow; streak	M.
14 1	3	28	+82	147	+42	53	Slow; streak	M.
14 45	1	353	+42	34	+67	33	,,	M.
14 53	1	308	+15	278	+39	35	,,	M.
15 3	1	140	+71	142	+52	19	,,	M.
May 4.								
14 34	2	286	+42	205	+50	55	Swift; streak	Be.
14 47	5	316	+29	306	+42	16	V. swift	Be.
May 5.								
14 20	3	16	+63	120	+66	40	Slow	S.
14 21	3	12	+60	110	+70	38	Swift; streak	D.
14 22	5	50	+72	111	+69	21	V. swift	G.
14 35	1	336	+29	26	+63	46	V. swift; streak	G.
14 56	2–3	330	+60	155	+69	52	Slow; streak	G.
14 19	4	309	+45	192	+57	65	Swift; streak	M.
14 35	4	205	+50	186	+34	21	,,	M.
14 50	♃	309	+45	192	+57	65	,,	M.
14 54	2	230	+60	182	+42	34	,,	M.
15 5	2	14	+88	165	+45	48	,,	M.
15 5	2	257	+66	187	+42	44	,,	M.
May 6.								
14 20	1	353	+43	27	+70	32	Slow; streak	M.
14 23	2	336	+47	28	+81	38	,,	M.
May 8.								
14 30	1	309	+45	199	+56	64	,,	M.

The observers were: M., Maggi, Volpeglino; I., Jadanza, Napoli; Z., Zona, Padova; V., Volante, Aosta; Gi., Garibaldi, Genova; Ba., Battezzati, Alessandria; Bz., Barizzone, Alessandria; Ga., Gai, Alessandria; C., Crabbio, Alessandria; Be., Bellucci, Perugia; S., Sosso, Moncalieri; D., Denza, Moncalieri; G., Giovanola, Moncalieri.

Bristol: 1882, *Dec.* 18.

Observations of Phenomena of Jupiter's Satellites, made at the University Observatory, Durham, in the Year 1882. By G. A. Goldney.

(*Communicated by the Rev. Professor Farrar, D.D.*)

Day of Observation.	Satellite.	Phenomenon.	Power.	G.M. Solar Time of Observation. h m s	G.M. Solar Time of N.A.
Jan. 7	III.	Tr. Ingr. First contact	195	6 29 37	6 32
		Bisection	,,	6 32 47	
		Last contact	,,	6 38 12	
7	I.	Tr. Egr. First contact	,,	10 37 2	10 40
		Bisection	,,	10 39 2	
		Last contact	,,	10 40 32	
7	II.	Ecl. R. First seen	,,	12 24 20·3	12 24 30
17	I.	Ecl. R. First seen	,,	5 27 36·8	5 27 36
		Full brightness	,,	5 29 25·3	
22	I.	Occ. D. First contact	,,	9 24 5	9 26
		Bisection	,,	9 25 35	
		Last seen	,,	9 26 40	
22	I.	Ecl. R. First seen	,,	12 54 45·3	12 54 30
		Full brightness	,,	12 57 9·3	
23	I.	Tr. Ingr. First contact	,,	6 38 12	6 39
		Bisection	,,	6 39 49	
		Last contact	,,	6 42 16	
23	II.	Tr. Ingr. First contact	,,	7 9 3	7 16
		Bisection	,,	7 11 13	
		Last contact	,,	7 14 38	
23	I.	Tr. Egr. Bisection	135	8 51 38	8 51
		Last contact	,,	8 53 48	
23	II.	Tr. Egr. Bisection	,,	9 50 13	9 54
		Last contact	,,	9 52 58	
24	I.	Ecl. R. First seen	195	7 23 38·2	7 23 33
		Full brightness	,,	7 25 30·2	
Feb. 1	III.	Occ. D. First contact	,,	7 32 2	7 45
		Bisection	,,	7 36 32	
		Last seen	,,	7 41 2	
	II.	Occ. D. First contact	500	6 49 1	6 52
		Bisection	,,	6 51 31	
		Last seen	,,	6 54 21	
8	I.	Tr. Egr. First contact	,,	7 6 1	7 8
		Bisection	,,	7 7 26	
		Last contact	,,	7 9 11	